

Draft Alternatives Review – Upstream Fish Passage at the Brunswick Project

ID	Alternative	Description	Effectiveness	Safety	Equipment Longevity	Risk/Uncertainty	Constructability	Construction Costs	Operation and Maintenance Costs	Impacts to Generation
U1	Modification of Existing Vertical Slot Ladder	<p>-This alternative would include modifying the existing vertical slot fishway to improve overall effectiveness.</p> <p>-The existing fishway has (42) 8.5-foot-wide by 10-foot-long pools with 11-inch slots.</p> <p>-The fishway was designed for a maximum drop per pool of 12 inches.</p> <p>-The ladder has a conveyance flow of 30 cfs and a supplemental attraction flow of 70 cfs for a total attraction flow of 100 cfs. The supplemental attraction flow is provided via a floor diffuser near the entrance.</p> <p>-The extent and feasibility of the modifications will be determined based on additional analysis and CFD modeling. Some potential modifications include:</p> <ul style="list-style-type: none"> Decreasing conveyance flow. The EDF (Energy Dissipation Factor) for the existing pools ranges from ~2.8 to 4.9 and is 4.0 at normal conditions. This is above USFWS’s recommendation of 3.15 for American Shad. Reducing conveyance flow to ~ 20 cfs would bring the EDF down to acceptable levels. Increasing supplemental attraction flow. Due to the geometry of the existing facility, it’s not feasible to increase the supplemental attraction flow through the existing fishway. To supplement the attraction flow, a ramped entrance diffuser similar to the one at the Scotland fishway may be able to be installed in front of the entrance. Review of the bathymetry in this area is required to assess the feasibility and determine amount of flow that could be provided. Total attraction flow will still likely be less than 5% of station discharge which is what’s recommended by USFWS. Modifying the fishway type. USFWS recommends a minimum slot width of 18 inches for American Shad. Increasing the slot width also requires that the pool size increases to maintain the hydraulic performance of the fishway. Increasing the pool sizes is not feasible due to the 	<p><u>Low/Moderate</u></p> <p>-A telemetry study of river herring conducted by NAI in 2022 showed an entrance efficiency of 37.5% and an overall internal effectiveness of 33.3%. A similar study for American shad in 2022 showed that only 2.4% of the tagged fish entered the attraction flow field and no fish entered the fishway.</p> <p>-Reducing conveyance flow would improve internal fishway hydraulics and improve internal efficiencies.</p> <p>-Increased supplemental attraction flow would improve entrance efficiency.</p> <p>-Smaller pool sizes mean a lower theoretical capacity than a new vertical slot fishway.</p> <p>-Overshot entrance gate should improve entrance efficacy.</p> <p>-Provides volitional passage (not currently operated due to invasive species).</p>	<p><u>Low Risk</u></p> <p>-Minimal changes to operating conditions.</p>	<p><u>Low</u></p> <p>-The bulk of the existing facility which was built in 1983 would remain in place.</p>	<p><u>High</u></p> <p>-Use of ramped entrance diffuser is limited.</p> <p>-The existing upstream fishway may need to be shut down for a portion of the season to facilitate construction.</p> <p>-Its unlikely that these modifications would improve effectiveness enough to meet the standards that the agencies will likely require.</p> <p>-Extension of the turning pool may be limited by property boundary or bridge easements.</p>	<p><u>Moderate</u></p> <p>-A small cofferdam near the fishway entrance would be required to facilitate potential modifications.</p> <p>-A cofferdam in the headpond would be required to facilitate construction of the attraction water intake structure.</p> <p>-Routing of new attraction water pipe may be difficult.</p>	<p><u>Moderate</u></p> <p>- Construction of ramped entrance diffuser.</p> <p>-Construction of entrance channel extension.</p> <p>-Installation of overshot entrance gate.</p> <p>-Installation of new dewatering gate.</p> <p>-Installation of flow induction pumps.</p> <p>-Modifications to internal fishway baffles.</p> <p>-Modifications to existing floor diffuser.</p> <p>-Replacement of wooden chamfers.</p> <p>-Installation of new attraction water pipe.</p> <p>-Construction of new attraction water intake.</p> <p>-Modifications to trap, sort, and truck facility.</p>	<p><u>Low/Moderate</u></p> <p>-Additional raking/cleaning of new attraction water intake.</p> <p>-No impact on parking, powerhouse access, or commercial traffic.</p> <p>-Vertical slot fishways are typically less complicated to maintain and operate. Pool and weir systems require more frequent operational adjustments for varying headwater and tailwater levels</p>	<p><u>Moderate</u></p> <p>-Additional losses due to increased attraction flow (likely to be less than a new vertical slot or fish lift).</p>

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		<p>site constraints. Modifying the fishway to a pool and chute style fishway may improve passage for shad. Additionally reducing the length of the pool from 10 feet to 8 feet would allow you to add 10 additional pools, reducing the drop per pool to 9 inches.</p> <ul style="list-style-type: none"> Increasing the size of the turning pool. It's unclear from the effectiveness testing that has been completed if the 180-degree turning pool at the downstream end of the fishway is problematic, but these have been an issue at other projects. Increasing the size of the tuning pool to further reduce the EDF and providing additional room for fish to rest could improve internal efficiencies. Modifying the existing floor diffuser. Some recent studies have indicated that floor diffusers can be an area of concern in fishways. Due to the geometry of the existing facility, it is not feasible to replace the existing floor diffuser with a wall diffuser, but it may be possible to improve the hydraulics at the floor diffuser by adding baffles, porosity plates, or turning vanes. Replacing the existing chamfered wooden corners with radiused steel plate or concrete. Extending the existing entrance downstream to allow for an overshot style entrance gate to be installed. Installation of flow induction pumps near the fishway entrance. Modify/Improve the existing trap, sort, and truck facility (Discuss with Brookfield). 								
U2	New Vertical Slot Ladder on South Side of the Powerhouse	<p>-This alternative would include constructing a new larger vertical slot fishway with a 9-inch drop per pool. Based on the maximum fishway operating head at the site (~ 40-feet), a vertical slot fishway with a 9-inch drop per pool would require approximately 52 pools.</p> <p>-The required pool size is based on the slot width. The minimum required slot width for American shad is 18 inches which results in a 12-foot-wide by 15-foot-long pool.</p>	<p><u>Moderate/High</u></p> <p>-Increased attraction flow would improve entrance efficiency.</p> <p>-Elimination of floor diffusers would improve internal fishway efficiency.</p>	<p><u>Low Risk</u></p> <p>-Similar operating procedures as the existing facility.</p>	<p><u>High</u></p> <p>-New fishway.</p> <p>-New trap, sort, and truck facility.</p>	<p><u>Moderate</u></p> <p>-Would likely require the existing upstream fishway to be shut down for multiple passage seasons to facilitate construction.</p> <p>-Footprint may be limited by property</p>	<p><u>Difficult</u></p> <p>-A large cofferdam in the tailrace would be required to facilitate construction of the fishway.</p> <p>-Complete demolition of the existing fishway would be required.</p>	<p><u>High</u></p> <p>-Construction of new vertical slot fishway.</p> <p>-Installation of new attraction water pipe.</p> <p>-Construction of new attraction water intake.</p>	<p><u>Moderate</u></p> <p>-Similar operating conditions to existing facility.</p> <p>-More pools to maintain.</p> <p>-Additional raking/cleaning of</p>	<p><u>High</u></p> <p>-Additional losses due to increased attraction flow.</p>

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		-This alternative would require the construction of a new trap, sort, and truck facility.	-Reduced drop per pool would improve internal fishway efficiency. -Larger pool sizes would increase the capacity of the fishway. -Length of the fishway may result in some fallback which would impact internal fishway efficiency. -Multiple switchbacks required could reduce effectiveness particularly for shad. -Would provide volitional passage.			boundary or bridge easements.	-Large impact area. -An SOE (support of excavation) structure to support the existing access road while the new facility is built would be required. -A cofferdam in the headpond would be required to facilitate construction of the attraction water intake structure and fishway exit. -Construction could impact access to the powerhouse.	-Construction of new trap, sort, and truck facility.	new attraction water intake. -Impacts parking, powerhouse access, and commercial traffic.	
U3	New Fish Lift on South Side of Powerhouse	-This alternative would include constructing a new fish lift to the south of the existing vertical slot fishway. -The hopper would be sized to accommodate the anticipated design population size (130,000 American shad, 600 Atlantic salmon, and 4.6M river herring). -This alternative would require the construction of a new trap, sort, and truck facility.	<u>High</u> -Increased attraction flow would improve entrance efficiency. -Elimination of floor diffusers would improve internal fishway efficiency. -Length of fishway is reduced which should improve internal efficiency. -Would not provide volitional passage.	<u>Moderate Risk</u> -Additional safety requirements associated with hopper lifting and fish lift operation.	<u>High</u> -New fish lift. -New trap, sort, and truck facility. -Remaining portion of existing fishway to be abandoned in place.	<u>Low</u> -Would likely require the existing upstream fishway be shut down for one passage season to facilitate construction. -Mechanical failures can result in the fishway being down for portions of the passage season.	<u>Moderate</u> -A cofferdam in the tailrace would be required to facilitate construction of the fishway. The cofferdam would be smaller than the one needed for the vertical slot fishway since most of the new fish lift would be on the land side of the existing fishway. -Portions of the existing fishway need to be demolished to facilitate construction. The remaining portion of the structure would be abandoned in place. -An SOE (support of excavation) structure to support the existing access road while the new facility is built would be required.	<u>High</u> -Construction of new fish lift. -Installation of new attraction water pipe. -Construction of new attraction water intake. -Construction of new trap, sort, and truck facility.	<u>High</u> -Fish lifts are more complex and have more mechanical components that need to be maintained. -Additional raking/cleaning of new attraction water intake. -Impacts parking, powerhouse access, and commercial traffic. -A secondary lift for trapping could be provided to allow some level of pre-sorting of species (similar to Milford).	<u>High</u> -Additional losses due to increased attraction flow.

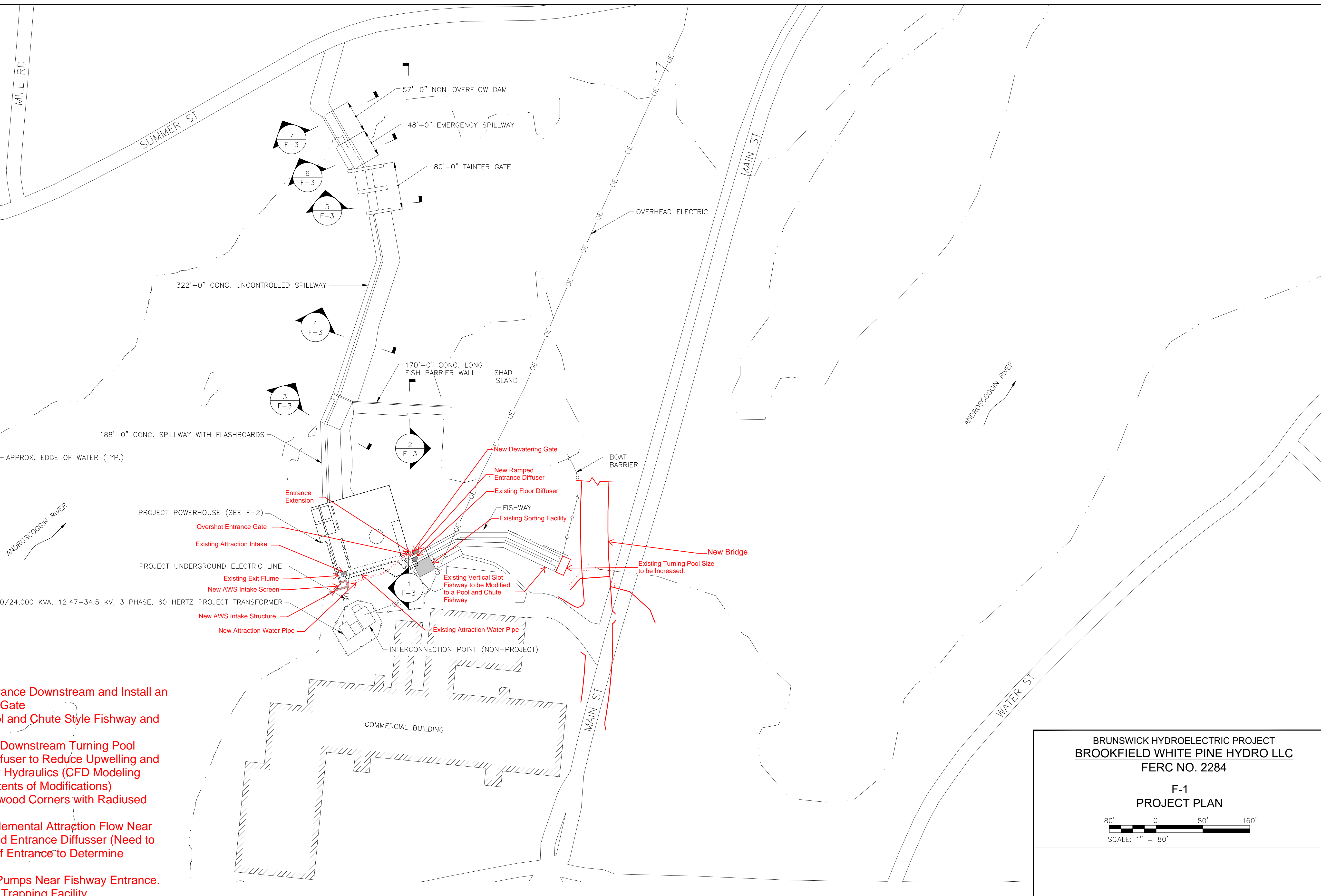
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							-A cofferdam in the headpond would be required to facilitate construction of the attraction water intake structure and fishway exit. -Construction could impact access to the powerhouse.			
U4	New FishHeart System	<p>-This alternative would include installation of a FishHeart collection system in the tailrace downstream of the powerhouse. The Fishheart system consists of a floating, in-water fish passage solution that uses a barge-mounted pump system to guide and transport fish over the dam. It uses pumped flow to attract fish into one of two 18-inch diameter pipes that are suspended below the barge where fish are captured and moved through the enclosed piping system and above the dam. Guide nets downstream of the structure help to guide fish into the system.</p> <p>-Fish could be pumped from the FishHeart system directly upstream or to the existing trap, sort, and truck facility.</p> <p>-Modify/Improve the existing trap, sort, and truck facility (Discuss with Brookfield).</p>	<p><u>Experimental</u> -This is still an experimental technology with some support from the agencies, though effectiveness for collecting the target species is still being studied.</p> <p>-The floating nature of the FishHeart system allows it to be repositioned as needed to optimize effectiveness.</p> <p>-Additional satellite entrances can be added as needed.</p> <p>-Could be used to supplement existing fishway.</p>	<p><u>High Risk</u> -A crane and boat access is needed to lift the Fishheart system into position.</p> <p>-Potential crane operation near overhead powerlines.</p> <p>-A boat and/or drivers may be required to maintain guidance nets.</p> <p>-Safety risk at high flows.</p>	<p><u>Moderate/High</u> -The Fishheart system is removed after each season and overhauled so that it is in optimal condition before each season.</p> <p>-The existing trap, sort, and truck facility would be reused.</p> <p>-Existing fishway could be abandoned in place or maintained for supplemental passage.</p>	<p><u>Experimental</u> -Additional testing of this system is needed.</p> <p>-The system uses two submerged pipes for entrances. Some species such as American shad may be hesitant to enter the pipes.</p> <p>-The system uses very little attraction flow which could impact overall effectiveness.</p>	<p><u>Easy</u> -The Fishheart system would minimize in-water construction.</p> <p>-This option would allow the existing upstream fish passage to operate if needed during construction.</p>	<p><u>Low</u> -Purchase of Fishheart System.</p> <p>-Installation of anchor points.</p> <p>-Modifications to trap, sort, and truck facility.</p>	<p><u>Moderate</u> -Integrated cameras with artificial intelligence allow for real time data collection and sorting. Sorting effectiveness is unknown.</p> <p>-Guidance nets could be a maintenance challenge during portions of the upstream passage season.</p> <p>-Requires annual installation and removal.</p> <p>-The Fishheart system is typically removed during high flow events.</p> <p>-No impact on parking, powerhouse access, or commercial traffic.</p>	<p><u>Low</u> -No attraction water from upstream of the dam is required.</p>
ALTERNATIVES RULED OUT										
-	No Action (Maintain Existing Conditions)	This was eliminated due to the low effectiveness of the existing fishway.	-	-	-	-	-	-	-	-
-	New Vertical Slot Fishway on North Side of Powerhouse	This was eliminated due to the limited real estate available between the powerhouse and Shad Island.	-	-	-	-	-	-	-	-
	New Fish Lift on North Side of Powerhouse	This was eliminated due to the limited real estate available between the powerhouse and Shad Island and the operations and maintenance challenges.	-	-	-	-	-	-	-	-
-	New Traditional Pool and Weir Ladder	This was ruled out due to the agency’s preference for vertical slot fishways in recent years.	-	-	-	-	-	-	-	-
-	New Denil Ladder	This was eliminated due to the anticipated design population at Brunswick (130,000 American shad, 600 Atlantic salmon, and 4.6M river herring).	-	-	-	-	-	-	-	-

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-	New Alaskan Steeppass	This was eliminated due to the anticipated design population at Brunswick (130,000 American shad, 600 Atlantic salmon, and 4.6M river herring).	-	-	-	-	-	-	-	-
-	New Whoosh System	This was eliminated due to the experimental nature of the technology and the limited success for American shad at prior on-site demonstrations.	-	-	-	-	-	-	-	-
-	New Nature-Like-Fishway	This was eliminated due to the required footprint and the limited amount of real estate available at Brunswick. The fishway entrance would also need to be located several hundred feet downstream of the powerhouse, which could adversely affect overall effectiveness.	-	-	-	-	-	-	-	-
-	New Fishway on Topsham Side of the Dam	This was eliminated as it would likely be less effective under non-spill conditions, the presence of the fish barrier dam, and the rock ledges that prevent fish from easily passing upstream to the spillway area.	-	-	-	-	-	-	-	-

MN
 14°47'W ± 0'6"
 AS OF 08/2024
 CHANGING BY
 0'6"E PER YEAR



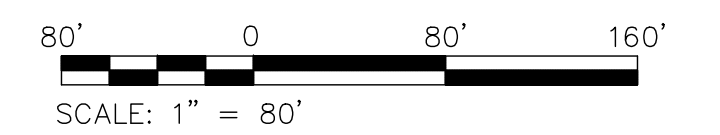
- Potential Modifications**
- Extend the Fishway Entrance Downstream and Install an Overshot Style Entrance Gate
 - Modify Fishway to a Pool and Chute Style Fishway and add 10 Additional Pools
 - Increase the Size of the Downstream Turning Pool
 - Modify Existing Floor Diffuser to Reduce Upwelling and Improve Internal Fishway Hydraulics (CFD Modeling Needed to Determine Extents of Modifications)
 - Replace Chamfered Plywood Corners with Radiused Concrete or Steel
 - Provide Additional/Supplemental Attraction Flow Near Entrance Using a Ramped Entrance Diffuser (Need to Review Bathymetry DS of Entrance to Determine Feasibility)
 - Provide Flow Induction Pumps Near Fishway Entrance.
 - Modify/Improve Existing Trapping Facility

PROJECT PLAN
 SCALE: 1"=80'

Alternative U1 - Modifications to Existing Fishway

BRUNSWICK HYDROELECTRIC PROJECT
 BROOKFIELD WHITE PINE HYDRO LLC
 FERC NO. 2284

F-1
 PROJECT PLAN



MN
14°47'W ± 0'6"
AS OF 08/2024
CHANGING BY
0'6"E PER YEAR

MILL RD

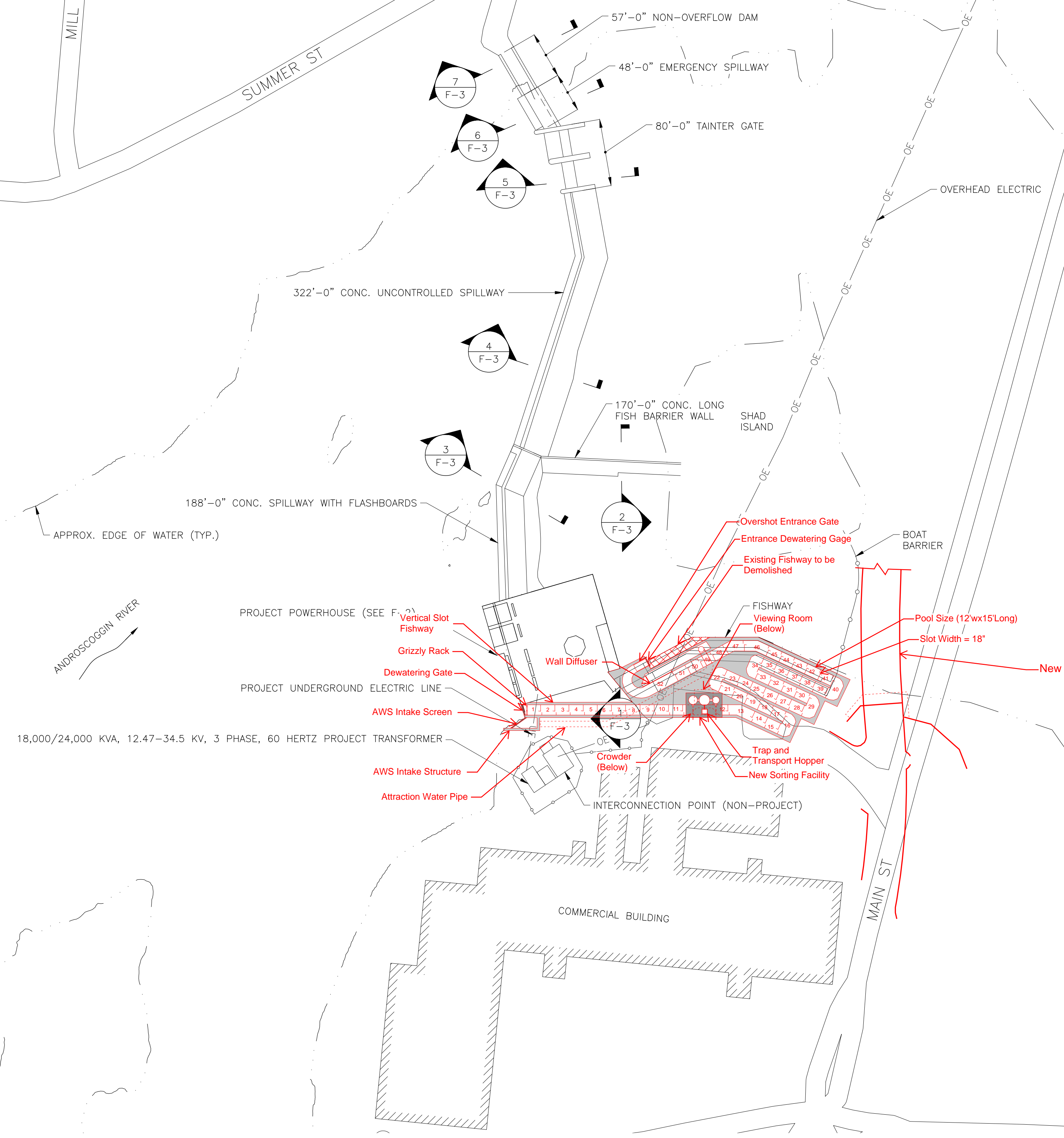
SUMMER ST

MAIN ST

ANDROSOGGIN RIVER

ANDROSOGGIN RIVER

WATER ST



APPROX. EDGE OF WATER (TYP.)

PROJECT POWERHOUSE (SEE F-2)

PROJECT UNDERGROUND ELECTRIC LINE

18,000/24,000 KVA, 12.47-34.5 KV, 3 PHASE, 60 HERTZ PROJECT TRANSFORMER

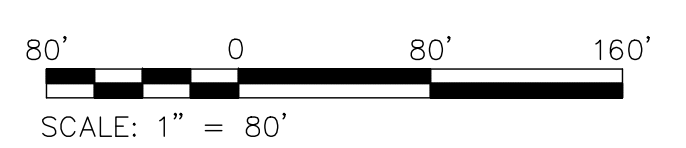
COMMERCIAL BUILDING

PROJECT PLAN
SCALE: 1"=80'

Alternative U2 - New Vertical Slot Fishway

BRUNSWICK HYDROELECTRIC PROJECT
BROOKFIELD WHITE PINE HYDRO LLC
FERC NO. 2284

F-1
PROJECT PLAN



MN
14°47'W ± 0'6"
AS OF 08/2024
CHANGING BY
0'6"E PER YEAR

MILL RD

SUMMER ST

MAIN ST

ANDROSCOGIN RIVER

WATER ST

ANDROSCOGIN RIVER

APPROX. EDGE OF WATER (TYP.)

18,000/24,000 KVA, 12.47-34.5 KV, 3 PHASE, 60 HERTZ PROJECT TRANSFORMER

PROJECT POWERHOUSE (SEE F-2)

PROJECT UNDERGROUND ELECTRIC LINE

Trap and Transport Hopper

Exit Flume

Grizzly Rack

Exit Flume Dewatering Gate

AWS Intake Screen

AWS Intake Structure

INTERCONNECTION POINT (NON-PROJECT)

COMMERCIAL BUILDING

7
F-3

6
F-3

5
F-3

4
F-3

3
F-3

2
F-3

1
F-3

PROJECT PLAN
SCALE: 1"=80'

57'-0" NON-OVERFLOW DAM

48'-0" EMERGENCY SPILLWAY

80'-0" TANTER GATE

322'-0" CONC. UNCONTROLLED SPILLWAY

170'-0" CONC. LONG FISH BARRIER WALL

SHAD ISLAND

188'-0" CONC. SPILLWAY WITH FLASHBOARDS

Overshot Entrance Gate

Entrance Dewatering Gate

Portion of Existing Fishway to be Demolished

New Training Wall

Portion of Existing Fishway to be Abandoned in Place

Wall Diffuser

DS Migrant Pipe

V-Trap

Main Hopper

Blocking Screen

Attraction Water Pipe

Exit Flume Conveyance Flow Screen

Crowder

New Sorting Facility

BOAT BARRIER

New Bridge

MAIN ST

OVERHEAD ELECTRIC

BRUNSWICK HYDROELECTRIC PROJECT
BROOKFIELD WHITE PINE HYDRO LLC
FERC NO. 2284

F-1
PROJECT PLAN

80' 0 80' 160'

SCALE: 1" = 80'

Alternative U3 - New Fish Lift

MN
14°47'W ± 0'6"
AS OF 08/2024
CHANGING BY
0'6"E PER YEAR

MILL RD

SUMMER ST

MAIN ST

WATER ST

ANDROSOGGIN RIVER

APPROX. EDGE OF WATER (TYP.)

18,000/24,000 KVA, 12.47-34.5 KV, 3 PHASE, 60 HERTZ PROJECT TRANSFORMER

PROJECT POWERHOUSE (SEE F-2)

PROJECT UNDERGROUND ELECTRIC LINE

COMMERCIAL BUILDING

PROJECT PLAN
SCALE: 1"=80'

57'-0" NON-OVERFLOW DAM
48'-0" EMERGENCY SPILLWAY
80'-0" TAINTER GATE

OVERHEAD ELECTRIC

322'-0" CONC. UNCONTROLLED SPILLWAY

170'-0" CONC. LONG FISH BARRIER WALL

SHAD ISLAND

188'-0" CONC. SPILLWAY WITH FLASHBOARDS

Gap in Net for DS Migrants

BOAT BARRIER

Anchor Cables

Guidance Nets

New Fishheart System

Existing Fishway to Remain

Transport Pipe To Exit Flume

Transport Pipe To Sorting Facility

Fishheart Control Building

New Bridge

Existing Sorting Facility

Existing Exit Flume

INTERCONNECTION POINT (NON-PROJECT)



BRUNSWICK HYDROELECTRIC PROJECT
BROOKFIELD WHITE PINE HYDRO LLC
FERC NO. 2284

F-1
PROJECT PLAN

80' 0 80' 160'

SCALE: 1" = 80'

Alternative U4 - New Fishheart System